Effect of Ammonium Hydroxide on Quality of Meat Products

Diofanor Acevedo-Correa¹, John Eduardo Rodríguez-Meza¹ and Raúl José Martelo²

¹ Research Group Innovación y Desarrollo Agropecuario y Agroindustrial
Universidad de Cartagena, Av. Consulado, Street 30 No. 48-152
130015 Cartagena de Indias, Colombia

² Faculty of Engineering, Research Group in Communications and Informatics Technologies GIMATICA. University of Cartagena

Abstract

This review summarizes the research on the use of ammonium hydroxide a very controversial chemical substance, generally used in the meat industry as a pH regulating agent, control of microorganisms, to increase the quality parameters of meat products among others. It provides a broad view of the controversy surrounding its use, until addressing the studies carried out by some authors, their main conclusions and the most important forms of detection; Although the research on ammonium hydroxide in food is very limited, it will be possible to appreciate all the benefits of this chemical agent. The results of this review show that the correct application of ammonium hydroxide following the principles of good manufacturing practices and established food standards contribute to improve some quality characteristics of meat derivatives, developing products with low activity of pathogens such as Escherichia Coli and Salmonella, innocuous and with longer useful life, nevertheless it is necessary to incorporate more research to comprehend in a broad way the mechanism of action in different percentages including as a chemical agent.

Keywords: Ammonium hydroxide, food preservation, pH, meat, microbiology
1. Introduction

Meat has a fundamental role in our daily diet, its high content of protein, source of vitamins and minerals are proof of this; one of the most widespread forms of consumption is the hamburger, whether it is the presentation of supermarkets or chains of fast food restaurants. The consumption of beef in Colombia has decreased in recent years, as reported by the most recent statistics of the Colombian Federation of Cattlemen that show an annual per capita consumption of 18.6 kg / habitant in 2016, compared to 19.1 kg / habitant in 2015 [1], these data correspond to the rise of the vegetarian culture worldwide, the globalisation of the excluding food variants of beef and that is generating an awareness increasingly marked in the consumers; While very few people are interested in "agriculture", everyone is interested in "food", as evidenced by the popularity of cooking shows on television, ranging from education to entertainment, where the best chefs get prestige and renown that in some cases exceeds many scientists, is also increasing the interest of consumers in healthier meats with lower fat content, organic, or at least free of chemicals and anti-biotic, which can be obtained, for example, improving disease resistance [2].

All this poses a complex challenge to maintain the quality and safety of meat and meat products, reducing the risks of contamination in food; Foodborne diseases (ETA) are a very serious public health problem in the United States, according to the Center for Disease Control and Prevention CDC, [3] annually 37 million people contract one of these diseases, resulting in more than 228,000 hospitalizations and 2,600 deaths; the global panorama is also alarming the World Health Organization [4] warns that each year up to 600 million people, or almost 1 in 10, get sick after eating contaminated food, of these 420,000 die, including 125,000 children less than 5 years old, so ETA is an important cause of morbidity and mortality and a huge impediment to global socioeconomic development.

One of the most used strategies to combat them is to remove contaminated products, withdrawals are important since they focus on eliminating the source of the problem to prevent additional diseases; some studies show the significantly negative influence on the behavior of consumers who stop consuming potentially contaminated foods, become fearful of purchasing these products, consequently withdrawals can also inflict serious damage in an industry by stigmatizing all similar products, including which are safe [5]. All the scandals associated with food security have an impact on the household consumption response and on the probability of acquiring the affected meat products in the future [6].

1.1 background

In the processing of beef for the production of sub-products, a highly controversial agent is sometimes used; Ammonium, also known as aqueous ammonia or ammonium hydroxide because it is a mixture of ammonia (NH3) and
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Water (H₂O), is generally recognized as safe (GRAS by its acronym in English Generally Recognized As Safe) by the FDA [7]. When used according to good manufacturing practices (BPM) for its applications as a leavening agent and food surface finishing, pH control OMRI [8] and elimination and identification of dyes [9, 10]. Ammonia, is a compound more common than imagined, we can find it in the environment, in plants and animals, in its digestive processes [11], enzymatic ruminal activities [12] and the body development phase of fish [13, 14].

In fact, the controversy of this chemical agent has its origin in the publications made by the winner of the Pulitzer Prize Michael Moss in The New York Times where the safety of the processing method of the beef is questioned to elaborate meat products, including the burgers from school lunch programs in the United States, according to Moss Beef Products Inc., established in South Dakota and led by Eldon N. Roth revolutionized the food industry by exposing meat to ammonia gas when it is shipped through pipes, then frozen and compressed, all these steps help eliminate pathogens such as Salmonella and E. coli; in essence, a reduction in contamination incidents was demonstrated to such an extent that officials of the United States Department of Agriculture (USDA) endorsed the company's ammonia treatment stating that it was destroyed E. coli "to an undetectable level", decided that it was so effective that they exempted these products from the routine tests they performed on hamburgers sold to the general public, however later the rejection of consumers who could perceive the presence of ammonia given its characteristic odor and isolated cases of microorganisms were reported, although no relationship could be established between the outbreaks with Beef Products Inc., officials said they would carefully examine the innovations of the meat industry to combat contamination, making sure that are scientifically sound, protect the salt public and examine the general government security policies on meat [15]. The controversy continued with statements issued by world-renowned chef Jamie Oliver on his television show Food Revolution where he discussed how a fast-food brand in the United States used ammonia in beef remains for hamburger preparation; before this process, according to him, the meat is not suitable for human consumption, cataloging it as harmful to health [16], based on the premise that consumers determine their own definitions of "good food" and healthy eating seeking guarantees of the quality of food [17]. Finally, a defamation litigation between Beef Products Inc. and the Walt Disney Company, owner of the ABC News unit, originated from a report by correspondent Jim Avila in 2012 on the safety of the LFTB (Finely textured meat cuts, Lean Finely Textured Beef, for its acronym in English) using the pejorative label of "pink slime" ("Pink slime" for its acronym in English) triggering losses in the company in the order of $1.9 billion in damages, sales fell and Beef Products Inc. closed three plants and laid off about 700 workers; in August of 2017 Disney declared in a statement that he had to pay $177 million dollars to solve the case, the publications were eliminated from the official ABC News page although Avila never retracted [18]. To date, the company has not ceased its interest in involving ammonia in the processing of meat, it can be corroborated in its official website in
the food safety section where they announce the process of making LFTB meat; this process includes ammonium hydroxide, arguing that there is no "ammonia-free" meat since this is an essential nutrient already present in meat and foods such as bread loaf (30 ppm NH₃), American cheese (813 ppm NH₃), mayonnaise (411 ppm NH₃) among others; the amount of the chemical agent increases very little because it is a powerful defense against potential germs [19].

1.2 Regulation

Ammonium hydroxide currently treated as harmless by the FDA and endorsed by other sources such as the Food and Agricultural Organization of the United Nations [20] and the World Food Organization. World Health Organization [4] is widely distributed in food engineering, an important fact because meat and its derivatives exhibit a tendency to rapid deterioration caused by its composition and the pH suitable for microbial growth. be treated with special care and greatly reduce the danger of contamination by undesirable pathogens such as salmonella and E. coli studies report the effectiveness of ammonium in these particular cases [21].

In addition, the Food Safety and Inspection Service (USDA) [22] responsible for the inspection of meat and poultry products to ensure safety and health for human consumption accepted its use as a pH control agent in brine solutions, although Consumers may not know when the chemical is in their food. Despite all the benefits of the correct use of ammonium hydroxide following the principles of BPM, the final consumer does not approve it, when questioning whether this chemical agent is in fact an ideal mechanism to guarantee food safety in meat products, especially in an era where more and more people prefer natural products, reaching a direct impact on the economy, for example in the United States meat exports as a percentage of production fell to 9.6% in 2015 compared to 10.6% [23], in Europe, for its part, in terms of value, cattle represent 8.1% of total agricultural production and 18.8% of animal production, without taking into account products of animal origin (for example, milk ) in the EU-28, between 2007 and 2014, the number of non-dairy cows decreased by 4%, from 12.5 to 12.0 million heads, this trend was especially noticeable in the EU-15, where the reduction reached 6% [24] Ammonium hydroxide is likewise treated as safe by many countries including the European Union and by international food safety organizations such as the Joint Committee of Experts on Food Additives (Joint Expert Committee on Food Additives) [25] JECFA, by its abbreviation in English, 1965) that allows its use in a wide variety of foods. The World Health Organization reported on the variety of foods that can be processed using this chemical agent applying good manufacturing practices, these foods encompass a range of dairy products, confectionery products, fruits, vegetables, baked goods, cereals, eggs, fish, sports drinks and beer, and meats. According to the European Agency for Chemical Substances and Mixtures, ammonium hydroxide is not an ingredient, but part of a manufacturing process [26].
2. Finally textured meat cuts (LFTB)

Given the changes in livestock production in the United States, the American beef companies found a processing technique that optimizes the product, called LFTB or FTB (Finely Textured Beef, Finely Textured Beef, for its acronym in English), its production recovers a considerable percentage of protein from fat cuts coming from bovine carcasses; the USDA considers LFTB / FTB to be equal to beef and pork for labeling purposes and can be used as a large source of lean meat; The composition of this product is high in protein (17-21%) and low in fat (8-12%) [27]. In addition, it can be added to sausages, hamburgers, ground beef and canned, the process used to create LFTB was developed by Beef Products Inc. through which the cuts of high fat meat (more than 40%) are heated (38 ° C). 50%), then go through a centrifuge to separate the fat, obtaining a product with 94% to 97% lean beef, later undergoes an antimicrobial process with ammonium hydroxide, freezes quickly and is pressed before added to ground beef and other foods [28]. The negative image of the LFTB originated by the reports presented in 2012 where the safety of this product was questioned triggered a media impact on the demand for these meats and other meats that may be able to serve as substitutes for the affected meat, since Consumers of this millennium rely heavily on the media on food safety events [29]. The coverage of the news and the reach of social networks on the use of finely textured meat show the influence on individuals and organizations [30], some companies have voluntarily decided to label their meat products with LFTB, while proponents of food safety in favor of the use of ammonium hydroxide in food safety have expressed concern that this controversy can curb future innovations in the meat industry [31].

In the process of transformation of beef carcasses are cut for wholesale consumption in large portions to be later divided into units to the retailer, there are fractions generated from this processing known as fat and lean cuts, can not be previously mechanically soften, rebuild, mark or marinate; they are used to manufacture some products that as mentioned above the media and some people called "pink slime", in LFTB and FTB obtaining the founder of Beef Products Inc. Eldon Roth creates in the meat an unsuitable environment for the survival of microorganisms when treated with ammonia or citric acid, bacteria that can cause serious foodborne illnesses such as Salmonella and E. coli O157: H7 inhabit the gastrointestinal tract or skin of animals and can contaminate meat through the line of sacrifice, affecting initially the surface of the carcass and from there the internal contamination to the muscular masses [32], however, many times the interior of the cuts remains protected from possible contamination and it is highly unlikely that pathogens migrate below that surface, during cooking, it is almost certain that the surface of these intact cuts will reach a temperature of 145 °F and allow three minutes of additional rest before consumption. The USDA for its part has approved the use of both treatme-
nts in the production of beef as processing aids; In accordance with the Code of
Federal Regulations, ammonium hydroxide and citric acid are considered as
processing aids and used to improve the attractiveness or usefulness of a food, nor
has it been established as a norm that food processing aids are labeled because
technically they do not alter the composition of the food, it is very probable that
the habitual consumers of products like the sausages, sausages and of course the
ground meat have acquired LFTB or FTB since the manufacturers include the
cuttings in variant levels and mix them with traditional meat; all advances in
technology have allowed processors to use these cuts in a sustainable way instead
of discarding them, optimizing the productive chain of the meat sector [33].

3. Researches

Studies have been reported on LFTB where they show that their incorporation in
products such as hamburgers in a percentage of up to 20% could provide many
positive quality characteristics, decreasing the oxidation of lipids and losses in the
cooking stage that together with the improvement of the fresh color, originate a
product with attributes of quality and good perception for consumers, the
inclusion of LFTB is a viable way that guarantees a more complete use of beef
carcasses, in its research the pH increased with the increase in LFTB levels
explained by the presence of ammonium hydroxide as a processing aid [34]. Other
publications on preference in taste, tenderness, juiciness and overall satisfaction of
the quality of hamburgers with varying percentages of finely textured beef proved
the positive results of the inclusion of LFTB [35]. The processing of improved
meat and poultry products often involves a common practice to control tenderness
variability, juiciness and reduce water loss by purging or dripping, whereby a
brine solution often containing water is administered, mixed salts (NaCl, KCl,
CaCl2 and MgCl2) [36] and other elements. In addition, they can contain
phosphates, exerting special effect on the sensitivity since it improves the capacity
of water retention by increasing the pH and solubilizes the myofibrillar proteins;
the use of phosphates as antimicrobials has been reported showing their
effectiveness against pathogens in meats and improves the oxidative stability of
ground meat [37]; Unfortunately, they contribute a sodium content to meat
products, so a non-sodium alternative could be 0.1% ammonium hydroxide to
replace sodium tripolyphosphate in beef injection brines, subsequent evaluations
reflected moisture content and Higher ash and almost 2% less protein in the
samples with phosphates, the fillets injected alkaline (0.1% ammonium
hydroxide) had lower aerobic counts (approximately 1 log less) and anaerobic
(approximately 2 log less) the final pH of the meat contributed in the differences
observed in the treatments [38] from a similar perspective [39] added 1%
ammonium hydroxide to beef tenderloins packed at 4°C in a modified atmosphere
rich in Oxygen (O 80% and CO 20%) simulating transport conditions during 0, 7
and 14 days concluding that the consumers during the first week could not
discriminate the color attribute in all samples, after 7 days the panelists gave the
highest rating to the treatments with addition of 1%; on the other hand, the fillets
with phosphates at 14 days were above the acceptance threshold for the perception of taste, no treatment at that date was acceptable in terms of color, in terms of microbial load they were questionable and probably were outside the range of shelflife. An extension of the previous investigation comparing fillets that have been injected with a commercial brine formulated with sodium phosphates and fillets that have been injected with a brine where the sodium phosphate in the formulation was replaced with 1% ammonium hydroxide exhibited a slight increase of the pH in the samples with ammonium (pH 5.96) while in the formulations with phosphates the pH reached 5.86, the treatment was favorable for the evaluation of the cooked meats since it reduces the flavor to spicy and salty, the results indicates that despite having a lower yield on cooking losses (23%), beef fillets have a palatable taste and palatability [39] phosphates are a substantial source of sodium, other investigations have been conducted to replace sodium tripolyphosphate in meats, controlling the percentages of the brine in an alkaline medium with 1% ammonium hydroxide, 3.6% NaCl and 1% Herbalox seasoning, which resulted in a promising advance of the change of phosphates and sodium in meats [40]; this successful replacement with ammonium hydroxide have a great importance for the meat processing industry, especially when is faced with obstacles such as PSE meats (Pale, soft and exudative, Pale, soft and exudative) and DFD (Dark, firm and dry, Dark, Firm and Dry, for its acronym in English) that are a major defect in the sector, have a smooth texture and a low water retention capacity (CRA), a phenomenon associated with pH and acute stress before of the sacrifice which causes changes in the biochemical parameters [41, 42], likewise it is relevant for health care; It has been reported that excessive sodium intake is associated with increased blood pressure (hypertension), one of the main risk factors for cardiovascular diseases and other health problems such as stomach cancer and kidney diseases [43].

At present, studies on the use of products for children are very limited, as previously reported the controversy generated around this has been the main obstacle; The available investigations evaluate the preference of consumers with different percentages of pumping (0%, 10%, 20% and 30%) using ammonium hydroxide, the results refer to the general acceptability at low levels 30%) the samples they had a slightly non-meaty texture and slight flavors; juiciness and tenderness yielded a similar behavior, at the same time increasing the pH with each ammonium treatment [44]. An economic characteristic of great importance is the tenderness of the meat, because it directly influences the reiterative levels of purchase by consumers, is dependent on many factors that makes it highly variable and unlike other phenotypes, the tenderness is not verifiable until after slaughter [45] and therefore the favorability of ammonium hydroxide in meats has been studied; Taste panels analysis revealed greater desirability for tenderness and other parameters such as juiciness, taste and general acceptability of beef fillets treated with ammonium in periods of aging of 1 to 3 weeks compared to untreated fillets [46].
It has been known that when ammonium hydroxide is mixed with cuts of meats the ammonia content can be increased but in a very controlled way and in much lower percentages, hence its use in food is recognized as safe by the FDA and allowed by control agencies in many countries to control the spread of Salmonella, E coli and other bacteria that could be present in meat trimmings [47]. In his research with beef fillets treated with ammonium hydroxide at a temperature of 5°C [48] they obtained lower counts of psychrotrophic, mesophilic and gram-negative bacteria, although he did not find differences in the bacterial counts of coliforms and lactic acid compared to the untreated control. The texture of meat products is a very important factor that must be controlled, is influenced by elements such as connective tissue proteins, the protein source organizes its lipophilic and hydrophilic structures to bind with lipids and water, which leads to the formation of emulsions by the addition of other non-meat ingredients; the collagen content, the size of the muscle fibers, the length of the carcomeros, the pH, the water retention capacity (CRA) and the emulsification capacity (CE) are determinants in the texture [49]. Some authors, such as Kiran et al., [50] have evaluated the effect of ammonium hydroxide on the texture of meat in their study to optimize the concentration of this agent in the effective softening of chicken meat in different concentrations (0.1%, 0.5% and 1.0% w/v), evaluated quality parameters after 24 hours, their results indicated a significant increase in pH, CRA, myofibrillar protein solubility and collagen solubility in samples with 0.5% and 1.0% ammonium hydroxide, there was also a significant overall reduction in cutting force Warner-Bratzler; a decrease in color intensity was revealed in all the treated samples compared to the control indicating the decomposition of proteins; a technique that can corroborate this event is the transmission electron microscopy (TEM, Transmission electron microscopy) that confirmed the proteolysis and the degradation of muscle fibers in the samples treated with ammonium, all the previous, evidence the benefits in meat texture softening effects of ammonium hydroxide in spent chicken meat at the tested concentrations, however, since no significant improvement in sensitivity was found at the level of 1% compared to the 0.5% level, it is advisable to use this last treatment.

The effect of ammonium hydroxide on the ultrastructure and tenderness of buffalo meat has been evaluated using the technique of marinating with distilled water and 0.1%, 0.5% and 1.0% ammonium solutions in pieces of biceps-femoral muscle meat, obtaining significantly increased the pH, CRA, the collagen solubility, the extraction of total and soluble proteins as well as the performance in cooking, also used an electrophoresis technique to corroborate that muscle proteins had a decrease in intensity and number of some protein bands in the samples with 0.1% and 0.5% ammonium hydroxide compared to the control that had only distilled water; an increase in the concentration of the treatments can cause a change in the osmolarity that has an effect on the solubility of the protein and generates a change in the pattern of bands, therefore a 0.5% solution of ammonium hydroxide is recommended to improve the tenderness of the pieces of meat, an additional technique such as scanning electron microscopy indicated an
evident contraction, reduction of the diameter of the muscle fibers and an external decomposition of the layers of the tissue surrounding the muscle fibers modifying the values of the force of Warner-Bratzler cut [51]. From a similar perspective the incidence of ammonium hydroxide in concentrations of 0.5%, 1% and 2% in the quality of hamburgers was studied during 9 days yielding important results regarding the reduction of the CRA to the highest concentrations of the agent, the researchers argued this fact in loss of the buffering capacity of the proteins as the distance from the isoelectric point increases, all this is linked to the increase of the pH, by the union of water molecules through hydrogen and ionic bonds to the hydrophilic sites of the polypeptides. In contrast the values of Hunterlab; technique widely used for the determination of color in food meat products [52, 53], increased for a* (redness) and b* in treated hamburgers compared to the control, the color readings corroborate the positive effects of ammonium hydroxide on the red hue of milled meat during storage in refrigeration in anaerobic medium, another particular revelation under these conditions is the reduction in the percentage of metamiogloblina in the samples with ammonium hydroxide until 9 days, probably caused by the oxidation of myoglobin in the control samples, generating an undesirable brown color, the incorporation of ammonium inhibits the formation of metamiogloblina becoming an effective treatment during refrigerated storage in the anaerobic conditions reported by the authors [54]. Ammonium hydroxide can also be used by the curing method [55] who used ham samples with PSE and DFD meats under the technology of Beef Products Inc., after the cooking process, the ammonium-enhanced hams had a higher pH for both types of meat, in contrast the control treatments had greater loss by cooking, compared with the DFD treatments, this study don’t found significant differences with respect to the moisture measurement in the meat / treatment type interaction as well as in the oxidation of lipids; Sensory evaluation data consisting of 150 panelists showed that hams with ammonium hydroxide had better qualification for general appearance and color, for the consumers the hams treated had better attributes of palatability and flavor in the two types of meat PSE and DFD, for all the above, the researchers report that the technology applied by the meat company of Roth is a viable method to sensorially improve hams and that can effectively raise the ratings for products made from PSE meat.

3.1. Detecció

Nitrogen is a nutrient present in the environment and essential for the development of many organisms, within its most common forms can be found ammonia; As this compound has been approached it is a colorless gas with a strong characteristic odor, given its high solubility in water it exists in an associated molecular form and ionized as ammonium NH₄⁺, the degree of association or ionization varies with respect to temperature and pH, as shown in Equation 1 the ammonia deprotonates a part of the water to generate the ammonium ions and hydroxide OH⁻ [56].
\[ NH_3 + H_2O \rightarrow NH_4^+ + OH^- \]  

Among the techniques for the determination of ammonia and its forms is Nesslerization, also known as the Nessler method, named for its creator by the German chemist Julius Nessler who developed a mixture with mercury iodide (II) and potassium iodide in an alkaline solution (Equation 2); this reagent raises the pH of the sample generating a precipitation of the hardness cations as hydroxides, when distilling the sample at a high pH a remnant containing the ammonia nitrogen is produced, however this method is very late so the most common form to eliminate the interference of hardness cations is to treat the samples with a solution based on zinc sulfate, filter and then add Rochelle or Seignette salt discovered in 1672 by Pierre Seignette that includes sodium and potassium tartrate (Equation 3 ) to remove residual hardness cations that could react with the Nessler reagent [57].

\[ 2K_2[HgI_4] + 3KOH + H_3N = HgI(H_2N) + HgO + 7KI + 2H_2O \]  

\[ KNaC_4H_4O_6 \cdot 4H_2O \]  

To analyze ammonia not ionized (NH3) and ammonium (NH4 +) is also used the method of Fenato that has its bases in the reaction of Bethelot in which the ammonia reacts with phenol and hypochlorite in an alkaline medium, then becomes monochloramine to pH 9.7-11.5 and reacts with phenol in the presence of hydrochlorine to form indophenol blue which is determined colorimetrically with a direct proportion to the presence of ammoniacal nitrogen, because the toxicity of phenol can be replaced with sodium salicylate; the most important limitation is the divalent cations that form insoluble compounds at a high pH, this reaction is not completely concrete for the ammonium ion taking into account that organic compounds react with the free amino group; Experiments on the ammonium adsorption have been carried out on activated carbon derived avocado seeds through the activation of methanesulfonic acid using the automated method of Fenato and UV spectrometry [58]. Previous studies have been applied to measure the content of ammoniacal nitrogen in agricultural biogas plants through the photometric valuation by titration, developing a polynomial regression model that relates the content of ammonium nitrogen with the volume of a strong acid under the premise of the influence of pH for the validation of this model [59].

Another method of great importance is the ion selective electrode (ISE, Ion selective electrode, also known as electrode for specific ions; in this the sample is alkalinized with sodium hydroxide to convert the ammonium and ammonia ions, once formed it diffuses through a permeable membrane to the gases of an ISE and the pH of its internal solution is altered, which in turn, it is detected by a pH electrode; the potential is measured by means of pH or ISE readers, when the pH
meter is used the ammonia content is established by a calibration curve whereas when the ISE meter is used the ammonia content can be obtained directly; organic compounds that form ammonia quickly are not a problem for this method as long as the concentrations do not exceed 100 mg / L [60]. The ISE technique responds to the concentration of a particular ion or gas in solution, the result corresponds to the potential difference that can be measured with a high impedance voltmeter, the voltage, according to the Nernst equation (Equation 4), it depends on the common logarithm of the activity of the ammonium ion or gaseous ammonia in the solution. The electrode for the detection of NH4 + has a polyvinyl chloride (PVC) membrane that contains an ammonium carrier, the sample is acidified to reduce the pH and convert all the gaseous ammonia to ammonium ion; the potential of the reference electrode of the NH4 + detection probes should be proportional to the content of the ammonium ion present in the sample; it is a practical method and saves time when there is a larger number of samples, although it has been reported to be less accurate [57].

\[
E = E^0 - \frac{RT}{nF} \ln(Q)
\]  

(4)

Where : \(E\) is the corrected potential of the electrode; \(E^0\) is the potential under standard conditions; \(R\) is the gas constant; \(T\) is the absolute temperature (Kelvin Scale); \(n\) is the amount of mol of electrons involved in the reaction; \(F\) is the Faraday constant (approximately 96500 C / mol); \(Q\) is the corresponding reaction quotient.

The detection of ammonia arouses a growing interest for a wide range of applications, including the food sector, a key challenge is to have selective detection materials (chemical / polymer) that are sensitive, environmentally stable and that meet the strict requirements imposed in the food area; one of these materials used is polyaniline, which requires the oxidation of the aniline monomers to react and form aniline dimers by the electrophilic substitution path, the continuous formation of oxidation sites of the cationic radical allows the growth of the aniline dimer, This technique uses interfacial synthesis, high dilution and other developments that combine polyaniline with other materials such as polyaniline nanocomposites with metal oxides, graphene, carbon nanotubes and others that have the ability to form electron interface interactions, achieving greater sensitivity and selective detection superior [61]. Other investigations have been carried out in different areas based on polyaniline for the detection of ammonia [62, 63].

### 3.2 alternatives

There are other techniques to improve the quality of food and ensure safety, as in the case of irradiation, a technology widely used in the food industry for its phytosanitary applications in products ready for consumption even in hospital diets
It has been reported that irradiation helps to extend the life of quail meat for at least two weeks at refrigeration temperature because it decreases microorganisms while retaining sensory attributes [65]. Other authors investigated the effect on irradiated pig emulsions, observing that these had greater solubility of the myofibrillar proteins and that treatment by ionizing radiation affects the physicochemical properties of meat products [66]. Cooked turkey meat was more susceptible to oxidation than raw meat at a lower irradiation dose [67]. However, another study in turkey breast meat found that irradiation accelerated the oxidation of lipids and proteins by increasing redness [67]. On the other hand, the use of ultrasound, a non-chemical "green" technology has been reported to improve the quality and safety of meat products, this technique decontaminates meat, inactivates microbial growth and improves tenderness when used by Whether alone or in combination with other methods of preservation or processing [68], other authors conclude that ultrasound is an emerging technique with the potential to accelerate maturation, reduce cooking energy and increase shelf life of meat products without affecting other quality properties [69]. Finally, the growing demand of consumers for healthier meat products has motivated the development of technologies such as high pressure processing (HPP) that helps improve shelf life without altering the sensory and nutritional properties of products, especially to reduce pathogens in foods such as salmonella, Listeria monocytogenes and Escherichia coli species [70], pulsed electric field treatment has also been applied in the food industry as a very promising, safe method with a potential bactericidal effect [71], although all these alternatives are advantageous, non-thermal technologies have a series of limitations that include the increase of oxidation reactions during the shelf life of meat products [72].

4. Conclusions

Despite the controversy triggered by the use of ammonium hydroxide in the food industry, especially in meat products, the series of advantages must be highlighted to improve the quality characteristics of meat, while producing safe, innocuous and longer shelf life. Useful; As previously mentioned, the chemical agent using correctly under the provisions of the corresponding regulations and good manufacturing practices is a potential method for food processing, but more research should be done to help understand the mechanism of action of hydroxide of ammonium in the different parameters of meat quality.

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